receive some sort of tentative answer through the researches of the palæontologists of the future. Prof. Flower is no doubt wise in not attempting to theorize on the subject; but this is the kind of question on which, in our experience, the "intelligent layman," whom the editor of the "Modern Science" series has in view, most greedily seeks information. Details of structure, no matter how clearly and lucidly described, do not appeal to him. He says, in effect, to the distinguished man of science: "My dear sir, from *you* I can take the details on trust; of them give me only sufficient to illustrate your methods of research: what I really want is your opinion on those broad general problems in which every man of liberal culture, who follows the thought of his time, must take a keen interest."

Prof. Flower divides his book into four chapters, of which the first deals with the horse's place in nature, and its ancestors and relations. The second chapter is devoted to the horse and its nearest existing relations. This contains a short account of the tapirs and the rhinoceroses, as well as the existing members of the horse tribe. The cuts with which it is illustrated are from photographs, and are admirable. The last two chapters (iii. and iv.) deal with the structure of the horse, chiefly as bearing upon its mode of life, its evolution, and its relation to other animal forms, the head and neck and the limbs being selected for detailed treatment.

Especially interesting are the paragraphs on the *ergot*, a roundish bare patch in the fetlock covered with rough thickened epidermis. It is suggested, and the suggestion is both valuable and interesting, that this represents

> "the palmar or plantar pads of those animals which walk more or less on the palm and sole. Owing to the modified position of the horse's foot, standing only on the end of the last joint of the one toe, this part of the foot no longer comes to the ground, and yet the pad with its bare and thickened epidermic covering, greatly shrunken in dimensions and concealed among the long hair around, and now apparently useless in the economy of the animal, remains as an eloquent testimony to the unity of the horse's structure with that of other mammals, and its probable descent from a more generalized form, for the well-being of whose life this structure was necessary."

Of the other callous patches, the so-called "chestnuts," or "mallenders" and "sallenders," which occur on the inner aspect in the fore-limb just above the "knee," and in the hind-limb just below the "hock," Prof. Flower says that their signification and utility are complete puzzles.

There are one or two misprints or inelegancies which will probably be removed in a second edition. On p. 52 we read: "The upper molars have a very characteristic pattern, admirably adapted for bruising and crushing coarse vegetable substances, and which is clearly a modification of the pattern," &c. Another redundant *and* before *which* occurs in the very awkward sentence on the top of p. 136. A somewhat quaint misprint occurs on the top of p. 68, where the "various species of the American general called *Merychippus* and *Protohippus*" are spoken of. One can imagine how the printer's devil prided himself on his knowledge of American proclivities. They give the name "general" even to an ancient fossil equine!

C. LL. M.

OUR BOOK SHELF.

A System of Sight-Singing from the Established Musical Notation, based on the Principle of Tonic Relation. By Sedley Taylor, M.A. (London: Macmillan and Co., 1891.)

THIS book is divided into two parts: (I.) the tonic sol-fa notation, (II.) the staff notation. Part I. differs from the "official" tonic sol-fa system only in the method of writing music in the minor key. Mr. Taylor is an out-and-out tonicist, and therefore most strongly opposed to the so-called "Lah mode" of the official system. It must be allowed that Mr. Taylor's method has the merit of consistency. For practical purposes, however, it is not so certain that the "Lah mode" is a mistake. At any rate, the opinion of most tonic sol-faists appears to be in its favour, as being the best method, from a utilitarian point of view, of treating the minor mode.

Part II. is an application of the tonic system to the ordinary staff notation. Mr. Taylor suggests that the line or space on which the tonic falls should be clearly marked by a thick line, of varying colours for major and minor keys. As long as there is little or no modulation in the music, there can be no objection to this, but when modulation sets in, the appearance which the stave assumes when these lines are inserted, becomes most puzzling. Two examples taken at random from the book will suffice to show this. In Ex. 142 the Do-line changes 6 times in the space of 9 bars of 2-4 time. Ex. 147, in 4-4 time, has 5 changes in as many bars.

It appears to us that these constant guides are calculated only to worry instead of directing the singer; "the graphic up-and-down-ness of the pitch-notation of the staff" (to use Mr. Taylor's words) seems to us to point out the way just as well without as with their assistance.

The book is most clear, logical, and interesting throughout; and whether one agrees with the reforms proposed in it or not, one cannot help feeling that the author, in his endeavours to minimize the difficulties of vocal music, deserves the thanks of all musicians.

The Statesman's Year-book for the Year 1892. Edited by J. Scott Keltie. (London: Macmillan and Co., 1892.)

THE "Statesman's Year-book" is too well known, and too highly appreciated, to need the commendation of reviewers. It presents such great masses of important facts, and these are generally so accurate and so well arranged, that the work has become indispensable to all who desire to obtain the latest information on the various subjects with which it deals. The changes for the year 1892 are described as "heavy and extensive," and all of them, we need scarcely say, add to the usefulness of the volume. The date of issue was somewhat later than usual; but it was well worth while to postpone publication, as the delay enabled the editor to include, among other valuable statistics, the results of the censuses of the leading countries of the world. This year the volume has been enriched with four admirably executed maps. They relate respectively to the density of the population of the globe on the basis of new censuses and estimates, the distribution of the British Empire over the globe, the partition of Africa, and the international frontiers on the Pamirs. These maps are most welcome, and will be of great service to all who may have occasion to refer to them.

The Optical Lantern as an Aid in Teaching. By C. H. Bothamley. (London: Hazell, Watson, and Viney, Limited, 1892.)

THOSE who wish to acquire a general knowledge with regard to the manipulation of an optical lantern, without

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entering into the minor details, will find in this little book a most useful guide. The author has dealt with the subject rather curtly, but nevertheless in this space the reader will find descriptions of various lanterns for different methods of projection; hints on the most suitable positions in which screens should be placed to be best viewed by audiences; the best kinds of burners for the lamps, both oil and oxy-hydrogen, and the different adjustments for producing good results. Many other useful hints are given, accompanied by several woodcuts. W.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Heat-Engines and Saline Solutions.

MR. MACFARLANE GRAY (p. 414) appears to call in question my assertion that in a vapour-engine a saline solution may take the place of a simple liquid when it is desired to replace water by a substance of less volatility, and that the advantage which Carnot proved to attend a high temperature can thus be attained without encountering an unduly high pressure. He contends that "the saline mixture is not the working substance. Carnot's law refers to the working substance only, and not to anything left in the boiler."

Perhaps the simplest way of meeting this objection is to point out that Maxwell's exposition of Carnot's engine ("Theory of Heat," chapter viii.) applies *without the change of a single word*, whether the substance in the cylinder be water, mercury, or an aqueous solution of chloride of calcium. In each case there is a definite relation between pressure and temperature; and (so far as the substance is concerned), all that is necessary for the reversible operation of the engine is that the various parts of the working substance should be in equilibrium with one another throughout.

Let us compare the behaviour of water in Carnot's engine before and after the addition of chloride of calcium, supposing that the maximum and minimum pressures are the same in the two cases. The only effect of the addition is to raise both the superior and the inferior temperatures. The heat rejected at the inferior temperature may still be available for the convenient operation of an engine working with pure water. At the upper limit, *all* the heat is received at the highest point of temperature—a state of things strongly contrasted with that which obtains when vapour rising from pure water is afterwards superheated. RAYLEIGH.

Superheated Steam.

LORD RAYLEIGH touches on a most important question (February 18, p. 375), which merits the attention of all interested in the economy of prime movers. Few have troubled themselves with determinations of temperatures and pressures within a steam generator. Ebullition means work, and the performance of work involves cooling; hence the temperature of steam in the steam space of any boiler is lower by several degrees than the temperature of the steaming water. I have failed to find any record of this important truth, and shall be glad to know if my observations have been anticipated.

Prof. Cotterill, in his work on the steam-engine (p. 33), referring to the process of formation of steam under rising pressure in a closed vessel, says:—"The mixture of steam and water must be supposed so treated that the temperature is sensibly uniform. If the experiment were tried without proper precautions, the steam would probably be found to be of higher temperature than the water—that is, it would be superheated." So far as my observations go, this is impossible, and the steam is never superheated by compression in a closed vessel, in contact with water.

In a small experimental boiler the records of temperature indicated as follows:—

Temperatures in Model Boiler working up to 10 *pounds pressure*

Water temperature 1¼ inches below upper level.	Steam temperature. Thermometer in steam space.	Pressure, pounds per square inch.
° F.	° F.	
100	87	—
120	106	—
140	126	—
158	145	—
174	164	—
188	179	—
200	192	—
212	205	—
215	212	—
226	222	5½
236	233	9½
239	235	10
239	235	10
239	235	10

To avoid supersaturation of the steam it must be separated as promptly as possible from the water, which it projects, more or less, into the steam space. It is this which renders it so important in practice to secure the most active circulation. Provision for this, whereby the water falls, whilst the steam rises, can be made.

Uniformity of temperature of the boiler contents is of the utmost importance; and I was recently told by an able engineer, connected with the Midland Railway, that the unequal expansion of the boiler plates in locomotives on getting up steam was not only disastrous in its consequences, but *impossible* of prevention. Pursuing thermometric experiments, I found this not to be the case, and on a first trial of suitable apparatus, I obtained the following result:—

Model Locomotive Boiler, showing Hottest Water at the Bottom under 212° (*October* 24, 1891).

	°	°	°	°	°	°	°	°	°
Upper level above fire...	60	80	90	100	110	120	130	140	150
Temperature below furnace ...	60	65	70	76	82	90	96	107	114
Upper level above fire...	160	170	180	190	196	198	199	204	209
Temperature below furnace ...	122	134	156	176	200	204	206	208	209
Upper level above fire...	212	212	—	—	—	—	—	—	—
Temperature below furnace ...	210	212	—	—	—	—	—	—	—

Lord Rayleigh's suggestion to use liquids of higher boiling-point than water, such as saline solutions, to get hotter steam whereby to raise the upper limit of temperature in a steam-engine, is not feasible. Increased elasticity of steam or increased tension was long since shown by John Sharpe ("Annals of Philosophy," vol. i. p. 459, 1813) to be due to a corresponding increase in its density. He pointed out that at 212° the density of steam was 150 times greater than at 32°, and at 252° it was twice as great as at 212°. Increasing the density of the liquid does not help us, but liquids of lower boiling-point yield vapours of higher density than steam at equivalent temperatures. Anhydrous ammonia vapour exerts a pressure of 4 atmospheres at 32°, and its density is about 0·2, whereas at 120° F. the pressure is in round figures 285 pounds on the square inch, and its density 0·850.

Properties of Saturated Steam as compared with Saturated (*Anhydrous*) *Ammonia Vapour.*

Steam.			Anhydrous ammonia.		
Pounds per square inch above the atmosphere.	Temperature in ° F.	Weight of steam in pounds per cubic foot.	Pounds per square inch above the atmosphere.	Temperature in ° F.	Weight of vapour in pounds per cubic foot.
	°			°	
15	249·8	·07344	14·744	0	·1060
30	273·9	·10790	32	20	·1639
60	307·2	·17493	57·607	40	·2428
120	349·8	·30503	113	70	·4096
165	372·8	·40053	164·7	90	·5587

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